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A MERGE-based Approach to Head Adjunction*

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Abstract

Chomsky (2017) redefined a syntactic operation, Merge, as MERGE in his lecture at the University of Reading. This redefined operation terminates some subspecies of Merge such as parallel Merge, late Merge, counter-cyclic IM without replacement/infixing. Namely, ‘multidominance’ or ‘two-peaked structure’ cannot survive. This termination suggests that internal pair-Merge of heads (i.e. head-adjunction) is no longer available because it potentially produces multidominance under MERGE. However, this paper proposes that MERGE can redefine internal pair-Merge of heads under Omune’s (2018a, b) pair-Merge of heads formulated by simplest Merge. As a result, this proposal ensures the basic derivation in Chomsky (2015a). Furthermore, the proposal is extended to ‘external’ pair-Merge of heads.

Keywords: MERGE, subspecies of Merge, pair-Merge of heads, workspace, seven desiderata

1. Introduction

In Chomsky’s (2017) lecture, a syntactic operation, Merge, was redefined as MERGE. This newly defined operation terminates several subspecies of Merge. This paper explores the possibility that MERGE redefines pair-Merge of heads under Omune’s (2018a, b) pair-Merge of heads formulated by simplest Merge. In the next paragraph of this section, I will introduce the current model of the minimalist syntax briefly, focusing specifically on freely applying Merge. Section 2 shows several key concepts, including MERGE as discussed in Chomsky’s (2017) lecture at the University of Reading. Section 3 first introduces a basic derivation under the free application of Merge and head-raising by MERGE as discussed in Kitahara (2017), and then points out the problems of the head-raising by MERGE. Section 4 presents four premises that are key to solving the problems. Section 5 proposes a new approach to head-raising, which is internal pair-Merge of heads, under MERGE. Section 6 extends this approach to external pair-Merge of heads. Section 7 concludes the paper.

The minimalist theory of syntax has been improved since the book *The Minimalist*

Program, which contains several papers by Noam Chomsky, was published in 1995 (Chomsky (1995b)). Each time an important revision is presented (e.g. Chomsky (1995a, b, 2000, 2001, 2004, 2008, 2013, 2015a)), the core syntactic operations have been ‘simplified’ in a sense, in terms of the SMT (Strong Minimalist Thesis). Roughly speaking, the SMT posits that language is the perfect system, satisfying interface conditions—that is, bare output conditions (see Chomsky (2001, 2010)). Since the FL (Faculty of Language) is in our brains, which is just part of our organs, it needs to conform to the physical principles that the science normally attempts to explain (i.e. the laws of nature). The minimalists call these the ‘third-factor’ principles (see Chomsky (2005)). In addition to the SMT and the third factor, evolvability, which is the possibility of the evolution of the language capacity, is a key concept to understand the nature of the FL. Assuming that human beings obtained the language capacity abruptly on the evolutionary timescale (see Chomsky (2014), Hauser, Chomsky, and Fitch (2002), Hauser et al. (2014), among others), the number of ‘language-unique’ operations must ideally decrease to one. Such a sole operation is assumed to be Merge, the structure-building operation that produces the simplest unordered sets, in a minimalist model (Chomsky (2013, 2015a)).

$$(1) \quad \text{Merge } (a, b) = \{a, b\}$$

When this Merge operation applies ‘externally,’ it takes two objects from the lexicon (or, if any, workspaces) and forms an unordered set. In contrast, if Merge applies ‘internally,’ it takes one entire SO (syntactic object) and another contained in that SO. We call the former EM (external Merge), and the latter IM (internal Merge)—IM corresponds, more or less, to Move in the earlier minimalist framework. Therefore, just one operation, Merge, ensures the basic properties of the FL, namely discrete infinity and displacement. Crucially, Merge applies ‘freely’ in any order, regardless of whether this is external or internal (see Chomsky (2015a), Epstein, Kitahara, and Seely (2016), among others). This operation is no longer a triggered operation as in the system of the probe-goal agreement (see Chomsky (2000, 2001, 2008)). In other words, applying Merge freely suggests that the current model is not *crash proof* (see Frampton and Gutmann (2002)), and C_{HL} (computational system for human language) produces deviant linguistic expressions. This is the natural assumption because our brain or mind is able to recognize which expression is deviant and which is not. However, how free is free Merge? Does free Merge allow subspecies such as parallel Merge (Citko (2005)), late Merge (Fox and Nissenbaum (1999)), and counter-cyclic IM without replacement/infixing (Epstein, Kitahara, and Seely (2012, 2014))? Chomsky (2017) answered ‘no’ to these

questions in his lecture at the University of Reading.

2. Assumptions from Chomsky's READING Lecture

Chomsky (2017) redefined Merge as MERGE, which applies to the WS (workspace). Syntacticians have tacitly presupposed the idea of WS because, for example, the formation of the embedded clause, which used to be called generalized transformation in Chomsky (1957), is impossible without WSs. Nobody, however, had seriously considered what the WS is and how it works. In Chomsky's (2017) talk, it seems that he attempted to determine the nature of the WS and how freely Merge/MERGE applies. Chomsky (2017) argued that it is essential for us to follow 'seven desiderata.'

(2) *Seven Desiderata:*

[1] Descriptive Adequacy (DA)

[2] Strong Minimalist Thesis (SMT; for example, IC and NTC)

[3] Restricting Computational Resources (RCR)

[4] Determinacy

[5] Stability (Condition of Coherence)

[6] Recursion

[7] Strict Binary (see Chomsky (2017) and Kitahara (2017))

The first desideratum is the DA (descriptive adequacy), which is familiar to syntacticians. Briefly put, it states that the structural description, which explains linguistic expressions syntactically, semantically, and phonologically, needs to capture the intuition of native speakers of a language. The second is the SMT (Strong Minimalist Thesis). In the minimalist model, the SMT, which states that language is the perfect system satisfying interface conditions such as the IC (Inclusiveness Condition) and the NTC (No Tampering Condition), is an extremely important notion to determine the nature of the language faculty. The third notion is RCR (Restricting Computational Resources). Each time we combine SOs in a WS, the total number of SOs should not increase, considering the SO finally built by MERGE is 'one.'¹⁾ That is, the resultant SO needs to contain just one mother node in the earlier term. Accordingly, MERGE should not expand the WS. This is a natural requirement because more than one SO cannot be read off by the interpretable systems, which are called the CI (conceptual-intentional) system and the SM (sensorimotor) system in the current model. In addition, Minimal Computation, which is one of the third factor principles, could lead to

the same conclusion. The fourth desideratum, determinacy, states that we must know that operations have applied in the determinate fashion, as far as I understand it. As Chomsky (2017) and Kitahara (2017) noted, if a SD (structural description) is for a rule for some WS, then the SC (structural change) must be unique. With regard to the fifth desideratum, the stability that is the condition of coherence, the interpretation of an SO cannot alter in the course of a derivation. The sixth one, recursion, is a universal property of human language. It means that a recursive procedure applies repeatedly. For example, MERGE applies repeatedly (and potentially limitlessly). According to Chomsky (2017), recursion ought to be free; any syntactic object must be accessible to further operations without any stipulation. Thus, this is the null hypothesis. The last desideratum is the strict binary. Syntacticians have considered that the binary branching is the key to revealing the structures of linguistic expressions due to several reasons. For example, morphological procedures clearly involve it. As in the case of the creation of the word *unhappily*, the prefix *un-*, the stem *happy*, and the suffix *-ly* do not combine at once, as the prefix and the stem combine first, followed by the suffix because *un-* modifies adjectives but not adverbs. In the current minimalist model, the SMT and the third factor entail the strict binary requirement; MERGE should be strictly binary. That is, MERGE affects only two SOs, not more (see also Chomsky (2015b: 82)).

Meeting all the seven desiderata, MERGE maps WS' to WS'' under the following definition:²⁾

- (3) Given a WS, a set of SOs, let Σ be the shortest sequence (X_1, \dots, X_n) such that
- (i) X_i is accessible, and
 - (ii) Σ exhausts the WS.

$$\text{MERGE}(\Sigma) = [X_1, X_2, X_3, \dots, X_n] \quad (\text{cf. Chomsky (2017) and Kitahara (2017)})$$

The square brackets indicate the WS, but the WS is just a set. Therefore, it should be noted that the square brackets are equivalent to the curly brackets that are used for unordered sets, although I do not use the latter for the WS to avoid the notational complexity.

Following the definition of MERGE, the EM of a and b results as follows:

- (4) $WS_1 = [a, b, c, d]$
 $\Sigma_1 = (a, b, c, d)$
 $\text{MERGE}(\Sigma_1) = WS_2 = [a, b, c, d]$

and the IM of c and $\{a, b, c\}$ is as follows:

- (5) $WS_1 = [\{a, b, c\}, d]$
 $\Sigma_1 = (c, \{a, b, c\}, d)$

$$\text{MERGE}(\Sigma_1) = \text{WS}_2 = [\{c, \{a, \{b, c\}\}, d]$$

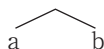
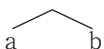
Both cases meet all the seven desiderata, and it is crucial that MERGE shows that EM and IM operate in exactly the same way. Whether IM was more costly than was EM, and vice versa, was debatable in the earlier framework (see Chomsky (1995b, 2000, 2001), among others). However, there is no such argument in the current model because both apply equally freely as argued in Chomsky (2015a), and MERGE now demonstrates this equality.

EM and IM are clearly good cases, and should be so because the minimalists have used them to explain various linguistic phenomena. Disputable cases are subspecies of Merge such as parallel Merge, late Merge, and counter-cyclic IM. In what follows, we first see how subspecies of Merge work out and then how MERGE eliminates them.³⁾

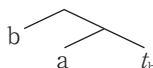
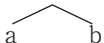
Citko (2005) argued that parallel Merge is the third version of Merge: EM, IM, and parallel Merge, which yields a multidominant structure.

- (6) a. EM (a, b) = {a, b}
- $$\begin{array}{cc} a & b \end{array}$$

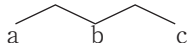
→


- b. IM (b, {a, b}) = {b, {a, b}}
- 

→


- c. Parallel Merge (c, {a, b}) = {a, b}, {b, c}
- 

→



In (6b), t_b denotes that this is the lower copy of b, and such a lower copy is, by definition, invisible. Also, note that every b in the set-theoretic notation of (6c) is the same b merged with both a and b, as shown in the graph-theoretic notation. Informally speaking, two nodes dominate the node b, which is multidominance. Late Merge operates in essentially the same way as parallel Merge. The different point is that late Merge potentially contains the operation ‘replacement,’ which is discussed by Epstein, Kitahara, and Seely (2012, 2014), among others. Essentially, replacement is counter-cyclic IM (e.g. counter-cyclic-subject raising) tacitly assumed in Chomsky (2000, 2001, 2008), among others.

- (7) a. {C, {_γ T, {DP, {v, VP}}}} ← IM of DP to _γ with replacement
- ↓
- b. {_{CP} C, {_{TP} DP, {T, {DP, {v, VP}}}}}

If there is no replacement, counter-cyclic IM of DP to _γ in (7a) should create the two-peaked structure as shown later in (9). However, replacement infixes DP into {C, {T, {DP, {v, VP}}}}. Such infixing enriches Merge/MERGE, which should be simple, and therefore must be

discarded.

Epstein, Kitahara, and Seely (2012, 2014) argued that counter-cyclic IM without replacement deduces cyclic Transfer. Provided that counter-cyclic-subject raising without replacement applies under counter-cyclic IM, the operation yields the following structure (9):

(8) $\{C, \{_{\gamma} T, \{DP, \{v, VP\}\}\}\}$ \leftarrow Counter-cyclic IM of DP to γ without replacement

(9) $\{_{CP} C$
 $\quad \swarrow$
 $\quad \{T, \{DP, \{v, VP\}\}\}$
 $\quad \nwarrow$
 $\{_{TP} DP$

(Epstein, Kitahara, and Seely (2014: 473))

The resultant structure is not acceptable, since it is a ‘two-peaked’ structure, which contains two mother nodes (i.e. CP and TP). Therefore, the TP (i.e. $\{_{TP} DP, \{T, \{DP, \{v, VP\}\}\}\}$) is transferred to the CI and SM systems and becomes inaccessible to operations under the PIC (Phase Impenetrability Condition; see Chomsky (2000, 2001)). The remaining structure is

(10) $\{_{CP} C$
 $\quad \swarrow$
 $\quad \{T, \{DP, \{v, VP\}\}\}$
 $\quad \nwarrow$
 $\{_{TP} DP$

where the shaded part and the dotted line are transferred. This is exactly what the operation Transfer does. In minimalist models, it is generally assumed that C and v^* are phase heads, and Transfer sends (the information of) the phase-head complement into the interpretive systems. Consequently, the phase-head complement becomes inaccessible (or unmodifiable) under the PIC. What counter-cyclic IM forms is an unacceptable structure, as in (9). Such two-peaked structures, however, lead to trigger the same effect as what Transfer does. Therefore, counter-cyclic IM with no replacement deduces Transfer that applies cyclically per a phase.

Based on the notion of applying Merge freely, it seems that parallel Merge and counter-cyclic IM might be possible because Merge applies ‘freely.’⁴⁾ On the contrary, MERGE does not give life to any other case except for EM and IM. Recall that EM and IM in (13)–(14) operate unproblematically, meeting all seven desiderata (11), following the definition of MERGE repeated in (12).

(11) *Seven Desiderata:*

[1] Descriptive Adequacy (DA)

[2] Strong Minimalist Thesis (SMT; for example, IC and NTC)

[3] Restricting Computational Resources (RCR)

[4] Determinacy

[5] Stability (Condition of Coherence)

[6] Recursion

[7] Strict Binary (=(2))

(12) Given a WS, a set of SOs, let Σ be the shortest sequence (X_1, \dots, X_n) such that

(i) X_i is accessible, and

(ii) Σ exhausts the WS

$\text{MERGE}(\Sigma) = [X_1, X_2, X_3, \dots, X_n]$ (=(3))

(13) *EM of a and b*

$\text{WS}_1 = [a, b, c, d]$

$\Sigma_1 = (a, b, c, d)$

$\text{MERGE}(\Sigma_1) = \text{WS}_2 = [a, b, c, d]$

$\sqrt{[1-7]}$: all desiderata are met. (=(4))

(14) *IM of c in {a, {b, c}}*

$\text{WS}_1 = [\{a, \{b, c\}\}, d]$

$\Sigma_1 = (c, \{a, \{b, c\}\}, d)$

$\text{MERGE}(\Sigma_1) = \text{WS}_2 = [\{c, \{a, \{b, c\}\}\}, d]$

$\sqrt{[1-7]}$: all desiderata are met (the lower copy c is, by definition, invisible). (=(5))

Let us consider the multidominance potentially created by subspecies of Merge such as parallel Merge, late Merge, (and perhaps sideward movement) under MERGE:

(15) $\text{WS}_1 = [a, \{b, \{c, d\}\}]$

$\Sigma_1 = (a, d, \{b, \{c, d\}\})$

$\text{MERGE}(\Sigma_1) = \text{WS}_2 = [a, d, \{b, \{c, d\}\}]$

*[1] DA is not met if d in {a, d} is identical to d in {b, {c, d}}; if permitted, it would circumvent any island violation.

*[4] Determinacy: if the operation applies to d, which d is it (assuming they are copies)? In {a, d} or {b, {c, d}}?

*[5] Stability is not met if d in {a, d} is a repetition of d in {b, {c, d}}.

*[7] Strictly Binary: a, d, and {b, {c, d}} are all affected.

(cf. Chomsky (2017) and Kitahara (2017))

Such a multidominant structure violates the desiderata [1], [4], [5], and [7]. The two-peaked structure by counter-cyclic IM even violates the desideratum [3].

(16) $\text{WS}_1 = [a, \{b, \{c, d\}\}]$

$\Sigma_1 = (d, \{b, \{c, d\}\}, \{a, \{b, \{c, d\}\}\})$

MERGE (Σ_1) = $WS_2 = [\{d, \{b, \{c, d\}\}, \{a, \{b, \{c, d\}\}\}]$

*[1] DA is not met if d and $\{b, \{c, d\}\}$ in $\{d, \{b, \{c, d\}\}\}$ are identical to d and $\{b, \{c, d\}\}$ in $\{a, \{b, \{c, d\}\}\}$, respectively.

*[3] RCR: $|WS_2| > |WS_1|$.

*[4] Determinacy: if the operation applies to d , which d is it (assuming they are copies)? In $\{d, \{b, \{c, d\}\}\}$ or $\{a, \{b, \{c, d\}\}\}$?

*[5] Stability is not met if d and $\{b, \{c, d\}\}$ in $\{d, \{b, \{c, d\}\}\}$ are repetitions of d and those of $\{b, \{c, d\}\}$ in $\{a, \{b, \{c, d\}\}\}$, respectively.

*[7] Strictly Binary: $d, \{b, \{c, d\}\}$, and $\{a, \{b, \{c, d\}\}\}$ are all affected.

(cf. Chomsky (2017) and Kitahara (2017))

The two-peaked structure violates the desiderata [1], [3], [4], [5], and [7]. Focusing on the RCR [3], the total number of SOs in WS_1 is one, but WS_2 contains two SOs. Chomsky (2017) furthermore considered a strange case of the merger not discussed in the literature:

(17) $WS_1 = [\{a, b\}, \{c, d\}]$

$\Sigma_1 = (b, c, \{a, b\}, \{c, d\})$

MERGE (Σ_1) = $WS_2 = [\{b, c\}, \{a, b\}, \{c, d\}]$

*[1] DA is not met if b and c in $\{b, c\}$ are identical to b in $\{a, b\}$ and c in $\{c, d\}$, respectively.

*[3] RCR: $|WS_2| > |WS_1|$.

*[4] Determinacy: if the operation applies to b , which b is it (assuming they are copies)? In $\{b, c\}$ or $\{a, b\}$?

*[5] Stability is not met if b and c in $\{b, c\}$ are repetitions of b in $\{a, b\}$ and those of c in $\{c, d\}$, respectively.

*[7] Strictly Binary: $b, c, \{a, b\}$, and $\{c, d\}$ are all affected.

(cf. Chomsky (2017) and Kitahara (2017))

In this case too, MERGE does not meet the desiderata [1], [3], [4], [5], and [7]. In conclusion, EM and IM meet the seven desiderata, but the other subspecies of Merge are no longer tenable under the conception of MERGE.

3. Derivation by Chomsky (2015a), Head-Raising by MERGE, and Problems

When applying Merge freely, derivations proceed strictly cyclically. For example, the structure of *John hit Mary* is constructed as follows:⁵⁾

- (18) $\{ \text{John}, \{ \langle R_{\text{hit}}, v^* \rangle, \{ \delta \text{ Mary}, \{ \gamma \ t_{\text{Rhit}}, t_{\text{Mary}} \} \} \} \}$ (*John hit Mary*)
- i. Merge externally forms $\{ \gamma \ R_{\text{hit}}, \text{Mary} \}$.
 - ii. Merge internally forms $\{ \delta \ \text{Mary}, \{ \gamma \ R_{\text{hit}}, t_{\text{Mary}} \} \}$.
 - iii. Merge externally forms $\{ \text{John}, \{ v^*, \{ \delta \ \text{Mary}, \{ \gamma \ R_{\text{hit}}, t_{\text{Mary}} \} \} \} \}$.
 - iv. R_{hit} inherits features from v^* .
 - v. Labeling takes place by minimal search: δ and γ are labeled as $\langle \text{Phi}, \text{Phi} \rangle$ and RP, respectively.
 - vi. Pair-Merge internally forms $\langle R_{\text{hit}}, v^* \rangle$ with v^* affixed: the affixed v^* becomes invisible, and the phase-hood is activated on t_{Rhit} .
 - vii. The complement of t_{Rhit} is transferred. (see Chomsky (2015a))

In this derivation, step (vi) is the problem; how does MERGE deal with internal pair-Merge of heads (i.e. head-raising) and ordered pairs such as $\langle R_{\text{hit}}, v^* \rangle$ (i.e. head-adjunction structures)?

Kitahara (2017) pointed out that, without postulating the ordered pair $\langle a, b \rangle$, simply applying MERGE does not ensure head-raising.

- (19) *A Demonstration of Head-Raising of c to a by Kitahara (2017)*

$$WS_1 = [\{a, \{b, \{c, d\}\}\}]$$

$$\Sigma_1 = (a, c, \{a, \{b, \{c, d\}\}\})$$

$$\text{MERGE}(\Sigma_1) = WS_2 = [\{a, c\}, \{a, \{b, \{c, d\}\}\}]$$

*[1] DA is not met if a and c in $\{a, c\}$ are identical to a and c in $\{a, \{b, \{c, d\}\}\}$.

*[3] RCR: $|WS_2| > |WS_1|$.

*[4] Determinacy: if the operation applies to c, which c is it (assuming they are copies)? In $\{a, c\}$ or $\{a, \{b, \{c, d\}\}\}$?

*[5] Stability is not met if a and c in $\{a, c\}$ are repetitions of a and c in $\{a, \{b, \{c, d\}\}\}$.

*[7] Strictly Binary: a, c, and $\{a, \{b, \{c, d\}\}\}$ are all affected.

In this derivation, the desiderata [1], [3], [4], [5], and [7] are not met. Kitahara (2017) therefore adopted a separate plane (or a separate domain in his term) introduced by Chomsky (2004) and avoided violating these desiderata. That is, he assumed that the “adjunction operation adds materials in a separate domain, and they are not accessible” (Kitahara (2017: 14)). If his assumption is on the right track, the following derivation holds:

- (20) $WS_1 = [\{a, \{b, \{c, d\}\}\}]$

$$\Sigma_1 = (a, c, \{a, \{b, \{c, d\}\}\})$$

$$\text{MERGE}(\Sigma_1) = WS_2 = [\{a, c\}, \{a, \{b, \{c, d\}\}\}], \text{ where } \{a, c\} \text{ is not accessible.}$$

All desiderata are met because $\{a, c\}$ is in the separate domain, and the resultant set is

regarded as $\{\{a, \{b, \{c, d\}\}\}$. Kitahara (2017) further assumed that, when Transfer applies to WS_2 , it treats the adjoined elements c as the other sister of a in $\{a, \{b, \{c, d\}\}$. In other words, his logic causes almost the same effects as what SIMPL does, in that SIMPL converts ordered pairs into unordered sets (see Chomsky (2004)).

However, Kitahara's MERGE-based approach to head-raising has two problems. First, it is not ideal to postulate the separate plane/domain in terms of the SMT and evolvability (see Omune (2018a, b)). Its postulation makes MERGE complex because MERGE needs to take an object to another domain. Postulating another domain or other domains is 'multidimensional.' Such multidimensions are not welcome. MERGE should be the simplest operation, considering the SMT, evolvability, and the third-factor Minimal Computation. Second, this mechanism potentially allows subspecies of Merge to work correctly. For example, see the case of (15), repeated below as (21).

$$\begin{aligned} (21) \quad WS_1 &= [a, \{b, \{c, d\}\}] \\ \Sigma_1 &= (a, d, \{b, \{c, d\}\}) \\ \text{MERGE}(\Sigma_1) &= WS_2 = [\{a, d\}, \{b, \{c, d\}\}] \end{aligned}$$

If we assume that parallel Merge or whatever takes elements to the separate plane, $\{a, d\}$ does not pose any problem because it is inaccessible. $\text{MERGE}(\Sigma_1)$ seemingly yields $\{\{b, \{c, d\}\}\}$, and Transfer (or an operation such as SIMPL) treats a as the other sister of d in $\{b, \{c, d\}\}$. This is an undesirable consequence because one advantage of MERGE is terminating subspecies of Merge. Thus, we need to consider an alternative MERGE-based analysis that solves the two problems.

4. Four Premises for MERGE to Derive the Effects of Pair-Merge of Heads

Omune (2018a, b) argued that pair-Merge of heads can be reformulated by simplest Merge because the following equation holds in the set theory, particularly in the ZFC (Zermelo-Fraenkel Set-Theory with the Axiom of Choices).⁶⁾

$$(22) \quad \text{Premise 1} \quad \langle a, b \rangle = \{a, \{a, b\}\} \quad (\text{cf. Tourlakis (2003: 182–183)})$$

Premise 1 states that ordered pairs can be defined as the unordered sets. Recall that what MERGE yields is just unordered sets, and MERGE is clearly able to form $\{a, \{a, b\}\}$. That is, EM first forms $\{a, b\}$, and IM then forms $\{a, \{a, b\}\}$. Furthermore, Omune (2018a, b) discussed that b in $\langle a, b \rangle$ is invisible/inaccessible (see (18vi)) for the following reason:

(23) *Premise 2*

b in $\langle a, b \rangle$ (i.e. $\{a, \{a, b\}\}$) is inaccessible because $f(a) = b$.

The ordered pair $\langle a, b \rangle$ (i.e. $\{a, \{a, b\}\}$) is equivalent to $f(a) = b$ in the set theory. That is, the value of b is automatically determined by that of a . What this means is that b is invisible unless the value of a is determined, but not vice versa. We do not need to see the value of b , which is invisible or inaccessible, since the value of a is what we need to see. In other words, a in $\langle a, b \rangle$ (i.e. $\{a, \{a, b\}\}$) uniquely identifies b without accessing b , because $f(a) = b$ corresponds to $\langle a, b \rangle$. Before moving to the third premise, we review step (18iv), which is the operation ‘feature inheritance.’ This operation makes a head (such as T or R) inherit all features of a phase head (such as C and v^*). Omune (2018a, b) presented the following proposal:

(24) *Premise 3*

Feature inheritance is minimal search, and it establishes a relation between relevant heads.

Feature inheritance occurs between two heads undergoing the application of internal pair-Merge of heads (i.e. head-raising). This inheritance should not be a primitive operation in the narrow syntax because MERGE must be the sole operation based on the genetic endowment or UG (universal grammar) in terms of the SMT and evolvability. Thus, Omune (2018a, b) argued that this operation was minimal search, which conforms to a third-factor principle Minimal Computation. The final premise relates to the timing of the application of head-raising. If premise 1 is tenable, head-raising or internal pair-Merge (see (18vi)) should apply before labeling by minimal search (see (18v)) occurs. Recall that premise 1 suggests that head-raising is instantiated by MERGE. According to Chomsky (2013, 2015a), labeling, which is just minimal search, applies when Transfer applies. Therefore, the following premise holds.⁷⁾

(25) *Premise 4*

Head-raising should apply before labeling as long as we assume that it is just one mode of syntactic movement instantiated by MERGE.

The four premises are all essential as long as we recapture head adjunction under the MERGE system. In what follows, I will demonstrate how the MERGE-based approach yields the same effects as what internal pair-Merge of heads does, without relying on undesirable multidimensions.

5. MERGE and Internal Pair-Merge of Heads

Reconsider the basic derivation of Chomsky (2015a) as in (18), repeated here as (26).

- (26) $\{ \text{John}, \{ \langle R_{\text{hit}}, v^* \rangle, \{ \delta \text{ Mary}, \{ \gamma t_{R_{\text{hit}}}, t_{\text{Mary}} \} \} \} \}$ (*John hit Mary*)
- i. Merge externally forms $\{ \gamma R_{\text{hit}}, \text{Mary} \}$.
 - ii. Merge internally forms $\{ \delta \text{ Mary}, \{ \gamma R_{\text{hit}}, t_{\text{Mary}} \} \}$.
 - iii. Merge externally forms $\{ \text{John}, \{ v^*, \{ \delta \text{ Mary}, \{ \gamma R_{\text{hit}}, t_{\text{Mary}} \} \} \} \}$.
 - iv. R_{hit} inherits features from v^* .
 - v. Labeling takes place by minimal search: δ and γ are labeled as $\langle \text{Phi}, \text{Phi} \rangle$ and RP, respectively.
 - vi. Pair-Merge internally forms $\langle R_{\text{hit}}, v^* \rangle$ with v^* affixed: the affixed v^* becomes invisible, and the phase-hood is activated on $t_{R_{\text{hit}}}$.
 - vii. The complement of $t_{R_{\text{hit}}}$ is transferred.

As argued above, we replace both Merge and Pair-Merge with MERGE and change the order of step (vi). Accordingly, the derivation is revised as follows:

- (27) $\{ \{ \text{John}, \{ R_{\text{hit}}, \{ R_{\text{hit}}, v^* \} \}, \{ \delta \text{ Mary}, \{ \gamma R_{\text{hit}}, t_{\text{Mary}} \} \} \} \}$ (*John hit Mary*)
- i. MERGE forms $\{ \gamma R_{\text{hit}}, \text{Mary} \}$.
 - ii. MERGE forms $\{ \delta \text{ Mary}, \{ \gamma R_{\text{hit}}, t_{\text{Mary}} \} \}$.
 - iii. MERGE forms $\{ \{ \text{John}, \{ v^*, \{ \delta \text{ Mary}, \{ \gamma R_{\text{hit}}, t_{\text{Mary}} \} \} \} \}$.
 - iv. Feature Inheritance by minimal search occurs: R_{hit} inherits features from v^* , and this inheritance establishes a relation between v^* and R.
 - v. When the next MERGE applies, MERGE takes advantages of the relation, and therefore it recognizes the WS as $\{ \{ \text{John}, \{ v^*, \{ \delta \text{ Mary}, \{ \gamma R_{\text{hit}}, t_{\text{Mary}} \} \} \} \}$, where the shaded part is inaccessible to MERGE.
 - vi. MERGE forms $\{ \{ \text{John}, \{ R_{\text{hit}}, v^* \}, \{ \delta \text{ Mary}, \{ \gamma R_{\text{hit}}, t_{\text{Mary}} \} \} \}$.
 - vii. MERGE forms $\{ \{ \text{John}, \{ R_{\text{hit}}, \{ R_{\text{hit}}, v^* \} \}, \{ \delta \text{ Mary}, \{ \gamma R_{\text{hit}}, t_{\text{Mary}} \} \} \}$.
 - viii. Labeling by minimal search occurs: δ and γ are labeled as $\langle \text{Phi}, \text{Phi} \rangle$ and RP, respectively.
 - ix. The complement of the lowest R_{hit} (i.e. t_{Mary}) is transferred.

When MERGE applies in (27v–vii), it takes advantage of the relation established by feature inheritance. The shaded parts, which are unrelated to the inheritance, are thus inaccessible to the operation. Accordingly, no technical problem emerges: the WS is not expanded, and a newly created $\{ R, \{ R, v^* \} \}$ is part of the entire set (cf. (19)). In addition, the analysis solves the

two problems in (19) because it does not adopt unpleasant notions such as the separate plane. Consequently, MERGE can deal with the head-raising in Chomsky (2015a) due to the special relation established by minimal search for feature inheritance. The more abstract derivation of the relevant head-raising by MERGE is shown below.⁸⁾

(28) *Head-Raising by MERGE*

- i. $WS_1 = \{ \{EA, \{v^*, \{IA, \{R, IA\}\}\} \}$
- ii. Feature inheritance (minimal search) establishes a relation between v^* and R.
- iii. $\Sigma_1 = (\{EA, \{v^*, \{IA, \{R, IA\}\}\})$
- iv. $MERGE(\Sigma_1) = WS_2 = \{ \{EA, \{R, v^*\}, \{IA, \{R, IA\}\} \}$
- v. $\Sigma_2 = (\{EA, \{R, \{R, v^*\}, \{IA, \{R, IA\}\}\})$
- vi. $MERGE(\Sigma_2) = WS_3 = \{ \{EA, \{R, \{R, v^*\}, \{IA, \{R, IA\}\}\} \}$
- vii. Labeling occurs.
- viii. The complement of the lowest R is transferred.

Crucially, it should be noted that this derivation meets the desideratum [4], determinacy, because $\{R, \{R, v^*\}\}$ is interpreted as $\langle R, v^* \rangle$, which is one amalgamated head (see Omune (2018a, b)). That is, $\{R, \{R, v^*\}\}$ is not R but a new head bearing the same property as v^* and R. After the relevant derivational processes are completed, C_{HL} recognizes that there is just one copy of R in WS_3 . Thus, it judges that the operations have applied in the determinate fashion. Moreover, the output of $MERGE(\Sigma_1)$, which is WS_2 , in (28iv) also meets determinacy because feature inheritance has read the hierarchical relation of v^* and R. MERGE can recognize which R is lower due to the information of this hierarchical relation. Recall that the lower copies that are contained in the same SO are, by definition, invisible.

One might ask how (28) resolves the problem of ‘replacement,’ which makes Merge/MERGE complicated (see Epstein, Kitahara, and Seely (2012, 2014)). In the derivational history of (28), v^* has merged with $\{IA, \{R, IA\}\}$, but $\{R, \{R, v^*\}\}$ has not. Unless we assume that MERGE replaces $\{v^*, \{IA, \{R, IA\}\}\}$ with $\{R, \{R, v^*\}, \{IA, \{R, IA\}\}\}$, we cannot obtain the desired resultant structure $\{EA, \{R, \{R, v^*\}, \{IA, \{R, IA\}\}\}$. There seem to be two ways to circumvent the replacement. First, we assume that feature inheritance solves the problem, as Omune (2018b) argued. As R inherits all features of v^* , R and v^* have the same property in some sense. This means that $\{R, \{R, v^*\}\}$, which is interpreted as $\langle R, v^* \rangle$ by C_{HL} , also has a similar property as v^* has because the amalgam $\{R, \{R, v^*\}\}$ is a head (see Chomsky (2015a)). If the relation between v^* and $\{IA, \{R, IA\}\}$ has already been established, it is rational that $\{R, \{R, v^*\}\}$ having the similar property of v^* could also establish the relation with $\{IA, \{R, IA\}\}$.

Second, we could assume that Transfer treats $\{R, \{R, v^*\}\}$ as a sister of $\{IA, \{R, IA\}\}$, which is similar to Kitahara's (2017) approach. To judge which approach is correct, we need additional researches.

The derivation by MERGE in (28) suggests an interesting consequence. MERGE (Σ_1) is closely equivalent to EM of v^* and R that leaves a copy of R because the other materials in the WS are inaccessible to the operation. As Chomsky (1995b, 2017) and Chomsky, Gallego, and Ott (2017) mention, EM potentially leaves copies without any stipulation. For example, let $WS = [a, b]$, and then $EM(\Sigma) = [[a, b], a, b]$. This is, however, not consistent with empirical phenomena. Thus, it is not assumed that EM leaves copies. In other words, $[[a, b], a, b]$ is replaced with $[[a, b]]$. MERGE (Σ_1) is, in essence, EM of v^* and R, and this operation leaves the copy of R. This suggests that EM leaving a copy is the adjunction operation. It is interesting that Nakashima (2018) argued that MERGE could address the phrasal adjunctions and reached a similar conclusion. It seems to be useful to redefine the adjunction operation from this point of view. Moreover, the lowest copy R in (28vi) has a distinctive property in Chomsky (2015a). When labeling and Transfer occur, this copy is assumed to be visible, contrary to the general property of lower copies (see also Epstein, Kitahara, and Seely (2016)), and therefore both labeling and Transfer are able to locate this R (see (27viii–ix)). It seems that this distinctive property could be caused by the copy created by the operation EM that leaves a copy. However, one point of MERGE (Σ_1) is fundamentally different from EM of v^* and R. The point is the non-expansion of a WS by MERGE (Σ_1) in (28). As mentioned earlier (see note 1), EM is the only operation that expands a WS, but MERGE (Σ_1) does not access the lexicon and therefore does not expand it. In conclusion, MERGE (Σ_1) is neither EM nor IM, but has the combined properties of both. The first property is merging two unstructured materials which have already been in a WS, and the second is leaving a copy. As far as I know, this new type of merger has not been discussed previously in the literature.

6. MERGE and External Pair-Merge of Heads

Epstein, Kitahara, and Seely (2016) proposed that pair-Merge of heads can apply 'externally.' It is logically natural because pair-Merge applies freely as long as pair-Merge is the syntactic operation. In addition, external pair-Merge explains various empirical linguistic phenomena such as the bridge-verb, passive, unergative, and unaccusative structures. For example, the derivation of the bridge-verb construction, *John thinks that ...*, is as follows:

(29) $\{ \text{John}, \{ \langle R_{\text{think}}, v^* \rangle, \{ \text{that}, \dots \} \} \}$ (*John thinks that ...*)

- i. Pair-Merge of heads externally forms $\langle R_{\text{think}}, v^* \rangle$: v^* becomes invisible with regard to both its unvalued Phi-features and its phase-hood.
- ii. Merge externally forms $\{ \text{John}, \{ \langle R_{\text{think}}, v^* \rangle, \{ \text{that}, \dots \} \} \}$.

This analysis solves the problem of the failure of labeling, regarding the bridge verb construction (see Epstein, Kitahara, and Seely (2016)). In this section, I discuss how MERGE can address external pair-Merge.

It seems that external pair-Merge of heads can easily be redefined by MERGE. For example, take a simple case: if $WS = [a, b, c]$, then $\Sigma = (a, b, c)$, which leads to $\text{MERGE}(\Sigma) = [\{a, b\}, c]$. This is exactly the same as the case of external MERGE. This case is, however, improper, as pair-Merge is not set-Merge, which is normal Merge forming unordered sets.

Premises 1 and 2 are crucial to capture the difference between the two operations, pair-Merge and set-Merge, under MERGE. Based on these premises, MERGE redefines external pair-Merge of heads as follows:

(30) $WS_1 = [a, b, c]$
 $\Sigma_1 = (a, b, c)$
 $\text{MERGE}(\Sigma_1) = WS_2 = [\{a, b\}, c]$
 $\Sigma_2 = (a, \{a, b\}, c)$
 $\text{MERGE}(\Sigma_2) = WS_3 = [\{a, \{a, b\}\}, c]$

As shown in premises 1 and 2, $\{a, \{a, b\}\} = \langle a, b \rangle$, the property of the ordered pair ensures the invisibility/inaccessibility of b in $\langle a, b \rangle$. Thus, (30) redefines pair-Merge under MERGE. To put it another way, this operation in (30), integrating with feature inheritance, applies in the case of (27)–(28) that is the instantiation of ‘internal’ pair-Merge of heads. We consider the concrete case of ‘external’ pair-Merge of heads in (30) below:

(31) $\{ \{ \text{John}, \{ \{ R_{\text{think}}, \{ R_{\text{think}}, v^* \} \}, \{ \text{that}, \dots \} \} \} \}$ (*John thinks that ...*)

- i. $WS_1 = [R_{\text{think}}, v^*, \{ \text{that}, \dots \}]$
- ii. $\Sigma_1 = (R_{\text{think}}, v^*, \{ \text{that}, \dots \})$
- iii. $\text{MERGE}(\Sigma_1) = WS_2 = [\{ R_{\text{think}}, v^* \}, \{ \text{that}, \dots \}]$
- iv. $\Sigma_2 = (R_{\text{think}}, \{ R_{\text{think}}, v^* \}, \{ \text{that}, \dots \})$
- v. $\text{MERGE}(\Sigma_2) = WS_3 = [\{ \{ R_{\text{think}}, \{ R_{\text{think}}, v^* \} \}, \{ \text{that}, \dots \} \}]$
- vi. $\Sigma_3 = (\{ R_{\text{think}}, \{ R_{\text{think}}, v^* \} \}, \{ \text{that}, \dots \})$
- vii. $\text{MERGE}(\Sigma_3) = WS_4 = [\{ \{ \{ R_{\text{think}}, \{ R_{\text{think}}, v^* \} \}, \{ \text{that}, \dots \} \} \}]$
- viii. $WS_5 = [\{ \text{John}, \{ \{ R_{\text{think}}, \{ R_{\text{think}}, v^* \} \}, \{ \text{that}, \dots \} \} \}]$

- ix. $\Sigma_4 = (\text{John}, \{\{R_{\text{think}}, \{R_{\text{think}}, v^*\}\}, \{\text{that}, \dots\}\})$
- x. $\text{MERGE}(\Sigma_4) = \text{WS}_6 = [\{\text{John}, \{\{R_{\text{think}}, \{R_{\text{think}}, v^*\}\}, \{\text{that}, \dots\}\}\}]$

(31i–v) are analogous to the application of external pair-Merge of heads. Premises 1 and 2 ensure that $\{R_{\text{think}}, \{R_{\text{think}}, v^*\}\}$ is interpreted as $\langle R_{\text{think}}, v^* \rangle$, which makes v^* inaccessible. Thus, (31i–v) keep all merits caused by external pair-Merge of heads intact. One of the merits is the phase-cancellation (see (29i)), which applies to all ‘weak’ phase structures such as bridge-verb, and passive ones. Furthermore, *John* is added to the WS_4 by MERGE (i.e. EM). Several irreverent parts are omitted, but the noun phrase *John* should also be formed by MERGE, since it is not a computational atom (i.e. head) but a set (i.e. phrase).

7. Conclusion

This paper has briefly reviewed the basic assumptions of the revised Merge, which is MERGE, discussed in the lecture by Chomsky (2017), and argued that Chomsky’s (2015a) derivational system works under MERGE with four critical premises that are motivated independently in Omune (2018a, b). In the discussion thus far, it has been shown that MERGE has the possibility of unifying pair-Merge of heads, regardless of whether pair-Merge is internal or external, as MERGE unifies EM, IM, and, if any, other types of Merge. Consequently, the analysis in this paper suggests that MERGE that produces the same effects as internal pair-Merge of heads does could be a new type of merger with the combined properties of EM and IM. This is the merger that does not take materials from the lexicon but selects the unstructured materials (i.e. heads) in the WS and leaves a copy there. In contrast, the merger corresponding to external pair-Merge of heads under MERGE is just the repeated application of MERGE: EM first, and then IM. Accordingly, the former, a head-raising such as R to v^* movement, applies only when feature inheritance connects the heads, but the latter, which is one of the general lexical mergers, applies freely. It is interesting that this generalization matches the general facts. Head-raising differs in each construction or in each language, but the creation of new words is a universal property in any language.

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Notes

- 1) There is one exception, which is when the operation (i.e. EM) takes an element or elements from the lexicon. Nobody can build SOs if there is no element in the workspace.
- 2) The latest definition of MERGE eliminates the shortest sequence Σ though it does not change the essential part of MERGE. This paper follows the original definition of MERGE by Chomsky (2017).
- 3) MERGE could also terminate sideward movement by Nunes (2001).
- 4) As far as I understand, the term ‘freely’ means that Merge applies ‘freely in any order.’ It thus does not actually say that applying Merge freely can form the multidominant structure or the two-peaked structure. The operation rather applies strictly cyclically as shown in Chomsky (2105a).
- 5) Labeling in (18v) occurs to determine what interpretation a targeted set has. Unless there is a label, the interpretive systems cannot decide if it is a noun phrase, a verb phrase, or the others (see Chomsky (2013)). Moreover, R is a (verbal) root that the affix v^* accords the status of ‘verb.’
- 6) Omune (2018a) assumed that this equation holds when both a and b are heads. Omune (2018b) further assumed that both a and b can be phrases.
- 7) See also Richards (2009), who argued that internal pair-Merge is one mode of syntactic movement for the first time, as far as I know.
- 8) EA is ‘external argument,’ and IA is ‘internal argument.’

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